

Introduction to *Closing the Loop*: Exploring Integrated Waste Management and Resource Conservation Kindergarten Through Grade Six

A Conceptual Approach with Project-Based Learning

The *Closing the Loop* (CTL) curriculum is designed to introduce students to integrated waste management through awareness, understanding, and action, and to encourage students to address today's solid waste problems. The lessons focus on becoming aware of natural resources and understanding alternatives to burying waste through reducing, reusing, and recycling, thereby conserving natural resources and extending the life of landfills.

By using CTL, teachers will be following recommendations from California's newly adopted content standards and curricular frameworks in a conceptual, interdisciplinary, and hands-on manner. Through specific projects, students apply what they have learned in the classroom and learn to follow certain practices in integrated waste management. Some project-based lessons are service-learning oriented, and in these lessons students participate in improving the environment in their school and community and have opportunities to educate others about what they have learned.

In spring, 1996, the staff at the California Integrated Waste Management Board's (CIWMB) Public Education Assistance Section decided to revise and update the existing *Closing the Loop* curriculum. The copyright for *Closing the Loop* was acquired by the CIWMB. The project director for the 2000 edition of *Closing the Loop* was Tricia Broddrick, and the project manager was Cara Morgan. Olga Clymire, an environmental education curriculum writer with the Lake County Office of Education, was hired to make the revisions.

The main goals for those preparing the 2000 edition of *Closing the Loop* were to revise the original CTL lessons to make them more applicable to California's content standards and curricular frameworks; provide additional lessons in integrated waste management, especially for teachers of kindergarten through grade three; develop concepts (main ideas) for each lesson; select children's literature and

reference books and videos to support the CTL lessons; and include suggestions for project-based learning. These goals were determined by a group of educators, which included teachers and representatives from the California Integrated Waste Management Board and the California Department of Education. This group also recommended separating the old *Closing the Loop* lessons into two modules: one for teachers of kindergarten through grade three and one for those teaching grades four through six.

Later, it was recommended that the following elements of an effective environmental education program be incorporated in the CTL units:

- Using thematic instruction
- Providing opportunities to teach lessons in built and natural settings
- Involving students in lifelong learning about local and global issues
- Engaging in ecologically responsible action projects
- Challenging students to use higher order thinking processes in the context of community issues
- Using hands-on and minds-on activities in classroom and field investigations

Forty-nine teachers throughout California field-tested the lessons in the revised version of *Closing the Loop*. The goals of this field test were to:

- Verify that the revised *Closing the Loop* lessons provide an enjoyable and successful learning experience for students.
- Make the lessons more applicable to the content and pedagogy recommended in the content standards and frameworks adopted by the California State Board of Education.
- Identify changes and corrections that need to be made to make the curriculum effective for classroom use.

Teachers who field-tested the new *Closing the Loop* said that the lessons were easy to imple-

ment and that their students thoroughly enjoyed participating in the hands-on activities. They especially liked the project-based lessons and the journal writing. Although some lessons require a fair amount of preparation, most materials can be reused in future lessons, making the preparation time for those lessons shorter. Recommendations by field testers and examples of students' work from the field testers were incorporated in the revised lessons. In addition, Bill Andrews, Director of the Office of Environmental Education in the California Department of Education (CDE), and Gary Smith, coordinator of several CDE environmental education projects, who was on leave from the Anaheim Joint Unified School District, reviewed these lessons. Also, over a dozen professionals in the integrated waste management field-checked the "Background Information for the Teacher" and the "Appendices" for technical accuracy.

Natasha Stillman from San Francisco's Solid Waste Management Program has reviewed the units and developed a solid waste jurisdiction-oriented information packet. This packet includes local information about the closest landfills; locations of recycling centers; available speakers; field trip opportunities; and classes, books, and videos available to teachers living in the San Francisco area. It is recommended that teachers contact staff from their local solid waste management agencies and encourage them to develop packets of information concerning integrated waste management in their communities. A template in "Appendix G" has been

designed to help guide the teacher to acquire information about local integrated waste management coordinators, facilities, and practices. For a copy of San Francisco's Solid Waste Management Program information packet, contact Natasha Stillman, School Education Coordinator, at (415) 554-3422; or the California Integrated Waste Management Board's Office of Integrated Education at (916) 341-6769.

The staff at the California Integrated Waste Management Board's Office of Integrated Education is planning to provide staff development opportunities for teachers. For information, call 916-341-6769.

It would be beneficial to those who use this curriculum if the staff at the California Integrated Waste Management Board were kept informed of teachers' experiences with the lessons. Any descriptions and photographs of projects that students complete and that are sent to CIWMB's Office of Integrated Education would be considered for the next edition of *Closing the Loop*. The address is:

Integrated Waste Management Board
Office of Integrated Education, MS-14A
1001 I Street
P.O. Box 4025 (mailing address)
Sacramento, CA 95812-4025

Components of Lessons and Page Layout in *Closing the Loop*

Most of the lessons in the 2000 edition of *Closing the Loop* are composed of 18 parts, which are identified and described in this section. Each lesson provides step-by-step instructions on how to implement the activities in the lesson. More

experienced teachers may choose not to follow this lengthier explanation of the activities. Instead, they can use the overview of each unit as an outline of what they will have their students do in each lesson.

Indicates lesson number and title of lesson.

Focuses on principal idea or ideas that lesson supports.

Specifies what students will learn.

Describes what students will be doing in the lesson.

Describes what students will do and learn and the correlations between this learning and the state's content standards and frameworks. In some lessons correlations to the *Benchmarks for Science Literacy* are also described.

Note about the correlations to California's content standards and frameworks: In this section, sentences in quotes indicate that the statements were taken directly from the standards, frameworks, or *Benchmarks for Science Literacy*.

LESSON 4: The Effects Worms Have on Soil

LESSON'S CONCEPTS

- Red worms turn food waste into compost that can be used to improve soil.
- People and other living things depend on soil.

PURPOSE

Students will learn how red worms improve soil and how people depend on the soil enriched by the worms.

OVERVIEW

In this lesson students will:

- Observe, touch, and describe soil.
- Examine and describe worm castings and compare them to soil.
- Discuss the effect worms have on soil and how their actions may benefit other organisms.
- Sing a song about the importance of worms and soil to people.
- Design collages showing ways people use soil.

CORRELATIONS TO CALIFORNIA'S CONTENT STANDARDS AND FRAMEWORKS

- Students work together as they observe soil and worms and make collages depicting people's use of and dependency on soil.
 - "Earth is made of materials that have distinct properties and provide resources for human activities. As a basis for understanding this concept, students know . . . rock, water, plants, and soil provide many resources, including food, fuel, and building materials that humans use." (*Science Content Standards, Grades K-12; Grade 2; Earth Sciences, Standard 3e*)
 - "Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for

understanding this concept . . . students will . . . observe common objects using the five senses." (*Science Content Standards, Grades K-12; Kindergarten; Investigation and Experimentation, Standard 4a*)

- "To participate effectively in society, students need to . . . develop group interaction skills." (*History-Social Science Framework, page 24*)
- "To develop geographic literacy, students must . . . understand human and environmental interaction." (*History-Social Science Framework, page 16*)
- Students describe in their journals why soil is important. They also describe how soil helped to supply one of their meals.
 - Students "select a focus when writing." (*English-Language Arts Content Standards for California Public Schools, Kindergarten Through Grade Twelve, page 8*)
 - Students "use descriptive words when writing." (*English-Language Arts Content Standards for California Public Schools, Kindergarten Through Grade Twelve, page 8*)

SCIENTIFIC THINKING PROCESSES

observing, communicating, comparing, relating

TIME

30-45 minutes to prepare for the lesson; 60-90 minutes to implement the lesson

VOCABULARY

worm castings, soil

K-3 Module
Unit 3

Signifies module and unit number. (Tabs are on the right-hand side of each right-facing page.)

Lists the processes, such as observing, communicating, comparing, ordering, classifying, relating, inferring, and applying.

Indicates how long the preparation and implementation of the lesson will take.

Contains words from the lesson with which students may not be familiar.

Note: The words introduced as new vocabulary in one lesson are not reintroduced in subsequent lessons.

K-3 Module, Unit 3:
Vermicomposting

U3-143

Lesson 4: The Effects
Worms Have on Soil

Note: The definitions for the vocabulary used in the lessons are provided in "Appendix E."

Identifies the tasks that the teacher needs to complete before starting the lesson (e.g., gather special materials, make transparencies, duplicate students' pages).

Lists what is needed to conduct the lesson.

Guides the teacher to determine what students currently know about the topic and concept (or concepts) of the lesson.

PREPARATION

1. Read the "Background Information for the Teacher" at the end of this lesson.
2. Collect worm castings from the worm bin. (If the worm bin has been operating for a couple of weeks, you should have at least a cup of worm castings.) Another place to get worm castings is from a worm supplier (see list in Lesson 1).
3. Write the words to "Soil Is Good" (page U3-147) on the chalkboard or piece of butcher paper.

MATERIALS

For "Pre-Activity Questions"

- Two cups of garden soil
- Two pieces of sandstone or dirt clods
- One-quart transparent plastic container with lid and enough water to fill it half full

For "Part I, Examining Worm Castings"

- A cup of worm castings from the worm bin (or from a worm supplier)
- Magnifying lenses

For "Part II, Identifying Ways People Use Soil"

- The transparency "Soil Is Good"
- Assorted magazines for students to locate pictures showing ways people use soil
- One sheet of construction or butcher paper for each group for the collages
- Nontoxic glue
- Scissors

For "Application"

- A resealable plastic sandwich bag for each group

PRE-ACTIVITY QUESTIONS

- A. Ask students to describe soil, as you write their responses on the chalkboard or on a piece of butcher paper.
- B. The following activity can be done outdoors or indoors. If going outdoors, bring the two cups of garden soil. Ask students to stand or sit in a circle.
 - Tell students that you will be giving some students handfuls of garden soil and that they should pass the soil to the persons on their left until all soil

samples have been passed all the way around the circle. If you are worried about students spilling the soil, place the soil in several small containers for them to pass around.

- Give several students handfuls of soil or containers of soil.
- As they are passing the soil around, ask students to feel the soil and to say words that describe this soil.
- After all students have passed around the soil, if it is not already in a container, gather the soil in a container.
- If outdoors, go back to the classroom and have students add to the list which describes soil. They should describe the soil they passed around.

Note: The reason that several handfuls of soil were passed around is that students might become more observant as they see several soil samples and hear other students describe them.

- C. Ask students what is in soil. *Dirt, pieces of plants, small rocks, water.* Write down students' responses under the heading "What Is in Soil?" on the chalkboard or a piece of butcher paper and save for later in the lesson. Discuss how students think soil is made. (Students might not know the answer at this time.)

- Tell students that they will simulate how water begins to make soil.
- Show two pieces of sandstone (or dirt clods). Place one in a plastic container of water and ask ten students to shake it ten times.
- Have students notice the particles of rock that are on the bottom of the container. Explain that particles of rock are in soil.
- Discuss some ways that rocks break down into smaller particles (e.g., wind, rain, sunlight, ice). Have students use the other piece of sandstone or dirt clod to demonstrate another way that rock breaks down into particles of soil.
- Can there be parts of plants and animals in soil? Yes. Ask students to explain. *When parts of plants or animals fall to the ground, they become part of*

The answers in *italics* are possible students' answers.

Note: Some students' answers in *italics* may not be correct, especially with the "Pre-Activity Questions" when teachers are assessing their students' understanding about a topic or concept.

Note: In the "Pre-Activity Questions" section, students sometimes develop a list of what they know. Later in the lesson, students edit and add to this list to show what they have learned. This sets up a format for a constructivist learning process in which students first identify what they know about a topic or concept. Then, through activities and projects, students construct (develop) their understanding. They revisit their original preconceptions to challenge their accuracy and scope, and then they finally apply this new understanding, usually by taking part in an activity or project or by teaching others.

Provides step-by-step directions for implementing the lesson.

soil. When plants and animals die, parts of them become soil.

PROCEDURE

Part I, Examining Worm Castings

- A. This activity can be done outdoors or indoors. Ask students to stand or sit in a circle. Bring a cup of worm castings (but do not tell students what they are).
 - Tell students that you will be giving them a mystery soil. They should keep passing the mystery soil to the person on their left until all students have had a chance to inspect it. If you are worried about students spilling the mystery soil, especially if they guess what it is, leave it in the container for them to feel as they pass it around.
 - Give a student a handful or a container of mystery soil.
 - Ask the student to feel the mystery soil and then to pass it to the student on his or her left.
 - As students are passing the mystery soil around, ask them to say words that describe this mystery soil.
 - After all students have passed around the handful of mystery soil, if it is not already in a container, place the mystery soil back in a container.
 - If outdoors, go back to the classroom and compile, on the chalkboard, a list of words that describe the mystery soil.
- B. Ask students how they think their mystery soil is similar to the garden soil they examined during the "Pre-Activity Questions" part of this lesson. *The soil is dark, crumbly. Ask students how it is different. It seems fluffier and darker in color.*
- C. Ask students to describe how they think this mystery soil was formed. Students' answers should relate to what they discussed about where soil comes from in the discussion in "Pre-Activity Questions."
- D. Have students guess where this mystery soil came from. Record students' responses. *The garden, from someone's yard.* Reveal to students, if they have not already guessed, the source of the mystery soil, which was their worm bin.

- E. Discuss with students how the worm castings were formed. Have students examine the worm bin's contents as you discuss this. *The worms ate the paper and food waste and produced worm castings.* You might want to have students revisit their thoughts on where their mystery soil came from and their comparisons to garden soil.
- F. Provide magnifying lenses for students to observe worm castings.

Note: Make certain that the children wash their hands after handling the worm castings.

Part II, Identifying Ways People Use Soil

- A. Have students sing "Soil Is Good" sung to the tune of "Doe, a Deer."
- B. Brainstorm what things people get from soil. *Food, building materials for homes, water from wells, materials for clothes.*
- C. Provide each group with several magazines. Allow approximately ten minutes for students to locate pictures of people using soil or of things that people need that they get from soil. Each student should cut out three or four pictures.



Optional

After groups have acquired pictures, ask students to categorize these items according to the different ways people use them. Have students explain these categories orally as you circulate among the groups. *Growing food, making clothing.*

- D. Ask students to make a collage out of the different ways that people use soil or items that come from soil. Provide a large piece of construction paper or butcher paper for group collages, scissors, and white nontoxic glue.
- E. Encourage groups to share their collages with the class.

DISCUSSION/QUESTIONS

- A. Discuss with students:
 - Based upon what you have learned about the worms in the worm bin, how

Encourages students to reflect on what they have learned. *Note:* Class discussions are often conducted to allow the teacher to determine whether the students grasped the concepts taught in the lesson.



Students in Lynda Mooney's first-grade class at Las Palmas Elementary School make a collage of ways people use soil.

do you think worms might help the soil? *They make castings. Remind students what they learned about nutrients in Lesson 3. When worms deposit castings in the soil, the castings become nutrients in the soil. Plants use these nutrients to live and grow. Worm castings are excellent soil enrichers.*

- Why is soil important to living things? *It provides them with food and shelter; plants grow in soil; animals walk on soil.*
- How do people use soil? *To grow fruits and vegetables, to build on, to walk on, to live on.*
- How does soil provide you with lunch? *Farmers grow food in soil, and I eat the food.*

- What would the world be like if all soil was like the sand from the beach? *Many plants could not grow. Not all animals could live in the sand. It would be hard to build on.*
- How do worms help improve the soil for people? *Worms add nutrients to the soil so people can grow food.*

- B. Ask students to review their responses at the beginning of the lesson about their descriptions of soil and "What Is in Soil?" Ask whether they think that everything on these lists is correct. If not, what would they change? What should be added? Ask students to explain their answers.
- C. Ask students to describe in their journals why soil is important. Encourage them to use descriptive words in the paragraphs that they write.

APPLICATION

Homework Assignment: Ask students to draw or write how soil helped to supply one of their meals (e.g., milk and pancakes—milk, cow, grass, soil; pancakes, wheat, soil; and syrup, maple tree, soil).

- A. Ask students to share their homework assignment by drawing on the chalkboard the steps from soil to one of their meals. Have students describe their drawings.
- B. Have students work in groups, and have each group find something to put into a resealable plastic sandwich bag that represents how soil is used by people or other

(Use the school's letterhead.)

Dear Parent or Guardian,

Please read the following information with your child:

As part of our vermicomposting unit, we are learning about the importance of soil and have discussed how our food comes from soil. Please assist your child in selecting a meal and then have your child illustrate with drawings and labels the role of soil in producing that meal. For example, if your child picked breakfast and had milk and pancakes, he or she would probably draw and label the following:

- Milk, cow, grass, soil
- Pancakes, wheat, soil
- Syrup, maple tree, soil

Thank you,

CLOSING THE LOOP

U3-146

K-3 Module, Unit 3:
Vermicomposting

Proposes a topic or concept from the lesson for students to write in their journals.

Describes activities for students to show what they have learned.

Suggests activities for students to complete at home.

Provides suggestions to parents about the homework assignment (or other information related to the lesson or unit).

Note about assessments: A variety of assessment components are provided in the "Discussion/Questions," "Application," and "Homework Assignments." In addition students' understanding of a lesson can be assessed through their writings and illustrations in their journals, which are assembled in the first lesson in Unit 1 in both the K-3 and 4-6 modules.

living things. This could be a piece of wood or paper (to represent that trees grow in soil and that people use wood or paper), an apple core (food), an illustration like a house (people build houses on soil or make parts of houses from materials found in soil), or a burrow (animals use soil for shelter). Then have groups switch their bags with another group and have each group describe what is in the bag they received and what the connection of the item in the bag is to soil.

- C. Ask students to write a sentence or two in their journals about what they have learned in this lesson. They can also draw a picture. Have them share their journal entries in small groups. Check each student's writing.

Project Idea: Have students plant flowers in planters on the school grounds or develop a school garden.

EXTENSIONS

- A. For an in-depth study of soil, implement Unit 2, "Protecting Soil," from *A Child's Place in the Environment* series.
- B. Sing "Dirt Made My Lunch" by the Banana Slug String Band (see "Resources, Audiotape").

RESOURCES

Video

Soil and Decomposition. New York: BFA Educational Media, 1986 (16 minutes).

Shows how plant fertilizer is made by nature and how it is manufactured by people. Time-lapse photography shows the decomposition process of dead leaves changing to fertilizer.

Books

Bourgeois-Addison, Paulette. *The Amazing Dirt Book*. Illustrated by Craig Terlson. Reading, Mass.: Addison-Wesley Publishing Company, 1990.

Contains activities to do with dirt.

Burke-Weiner, Kimberly. *The Maybe Garden*. Hillsboro, Ore.: Beyond Words Publishing Co., 1992.

A woman with a beautiful garden encourages her child to plant various plants. The child

imagines things which could be done with each plant.

Curricular Guide

Clymire, Olga. *Protecting Soil*. Unit 2 of *A Child's Place in the Environment* series. Sacramento: California Department of Education, 1997.

Contains 20 interdisciplinary lessons that focus on the importance of soil and culminates in a soil-enriching project. The lessons integrate science, history-social science, and English-language arts.

Audiotape

Dirt Made My Lunch, recorded by the Banana Slug String Band, includes the song "Dirt Made My Lunch" by Steve Van Zandt. Music for Little People, 1989.

A tape and booklet with the words to this and other environmentally-oriented songs.

SOIL IS GOOD

(Sung to the tune of
"Doe, a Deer")

When you dig in the moist, brown
earth,
You will find bugs, plants, and
worms.
Soil is home for squirmy worms,
Ants and slugs and also germs.
Soil needs air to make life thrive,
So the underground world will stay
alive.

We need soil to grow our food.

Soil is life;

It feeds us good! good! good! good!

Submitted by Gayle MacDonald-Cura's third-grade
class, Lower Lake Elementary School, Konoti
Unified School District.

Suggests
activities for
further study
on the topic
of the lesson.

Contains lists
of videos, books,
Web sites, and
other resources
applicable to the
lesson for teachers
and students.

Note: At the end of
each lesson is a list
of resources. These
resources are not
required to implement
the lesson but can be
used to support the
lesson or provide
further study of the
subjects or concepts
introduced in the
lesson.

Note: "Appendix A, Instructional Materials," is a compilation of all the resources listed in all lessons. Also, "Appendix F, Web sites," is a compilation of Web sites on various topics applicable to integrated waste management.

BACKGROUND INFORMATION FOR THE TEACHER

In this lesson, students will be learning about soil and its importance to living things, including people.

Soil is made up of various sizes of rock (mineral) particles (e.g., sand, silt, clay), water, air, living organisms, and parts of decomposing dead plants and animals. Soil provides a place for terrestrial (land) plants to live. The plants obtain water and nutrients from the soil and use it for anchoring their roots. Many animals also use soil. Some obtain nourishment from dead plant and animal matter; others feed on soil organisms. Some animals (e.g., ground squirrels and burrowing owls) might use soil as shelter from predators and extreme temperatures.

People use soil to grow plants for food (e.g., corn), fiber (e.g., cotton), and shelter (e.g., Douglas fir tree). People mine, from soil and rocks, a variety of minerals (e.g., iron, copper) for building and manufacturing products.

People also build many things on top of soil, including homes, stores and other businesses, and roads.

Almost everything people eat comes either directly or indirectly from the soil. Most vegetables, fruits, and grains for bread and cereals are grown in soil. The animals some people eat, like chickens or cows, get their nutrition from plants that grow in the soil. Milk products come from cattle that feed on grass grown in soil.

People depend on healthy soil. An effective method for improving soil is by adding compost or vermicompost, both of which are full of nutrients that plants need in order to live and grow.

Vermicomposting has many benefits to people and the environment. Not only does it produce nutrient-rich castings, but it is also an effective recycling option. The worms eat organic material, such as paper and food waste, and turn it into a rich organic soil amendment. This eliminates the need to dispose of organic material in a landfill. For more information on organic materials, see "Appendix C-VI, Organic Materials," and "Appendix D-II, Maintaining a Vermicomposting System."

Provides information on the concepts and topics of the lesson. The teacher is often referred to specific sections of the "Appendix" for additional information.

Other information: The 2000 edition of *Closing the Loop* follows *The Chicago Manual of Style*, 14th Edition, for issues of style, and the spelling is based on *Merriam-Webster's Collegiate Dictionary*, Tenth Edition.

Tips for Implementing Projects

One way that students can learn firsthand and apply what they have learned is by participating in projects. The *Merriam Webster's Collegiate Dictionary* (Tenth edition), 1994, defines *project* as:

A specific plan or design. A definitely formulated piece of research. A task or problem engaged in usually by a group of students to supplement and apply classroom studies.¹

According to this definition, students plan and design the project. They might do research by having firsthand experiences or by reading about or listening to the experiences of others. They might work individually, in pairs, in small groups, or as a class to supplement and apply classroom studies. As a result of their participation in projects, the students are more likely to learn more, to enjoy the process of learning, and be well on the way to becoming lifelong learners.

A more formal approach to implementing projects is called *project-based learning*. Autodesk Foundation partially defines project-based learning as: "Engaging learning experiences that involve students in complex, real-world projects through which they develop and apply skills and knowledge." Furthermore, this type of learning includes "experiences through which students learn to manage and allocate resources such as time and materials."²

The Autodesk Foundation asked a group of teachers and administrators from 17 schools to come up with a definition of project-based learning. They agreed that a project needs to have the following characteristics to be considered project-based learning:³

- The kids are making decisions, and they have a framework in which to do so.
- There's a problem without a predetermined solution.
- Kids design the process for reaching a solution.
- Kids are in charge of accessing and managing the information they gather.
- Evaluation takes place continuously.
- Kids have a chance to reflect on what they're doing.

¹*Merriam Webster's Collegiate Dictionary* (Tenth edition.) Springfield, Mass., 1994, p. 932.

²From the Autodesk Foundation's Web site, www.autodesk.com/foundation, December 12, 1998.

³*Ibid.*

- A final product (not necessarily material) results and is evaluated for quality.
- The classroom has an atmosphere that tolerates error and change.

In the *Closing the Loop* (CTL) curriculum, students have opportunities to engage in many different types of projects. Some are relatively simple, such as designing a game made out of discarded materials. Other are more involved, such as vermicomposting in the classroom. And still others will take large amounts of time and dedication, such as designing a campaign to reduce waste on a schoolwide basis, organizing schoolwide recycling, or developing and implementing a plan to compost cafeteria food waste. Note that not all projects recommended in CTL can be considered project-based learning, based on the criteria cited above.

The following ideas were gathered by the author when attending a project-based learning conference held in San Francisco on March 14 and 15, 1998. Some tips for implementing individual or small group projects are provided below:

- Provide choices of projects for students. This will empower the students to be responsible for the project selected.
- Support students in designing their own process for completing the project. (Make the process of implementing the project as important as the product.)
- Develop a rubric with the class to assess students' progress of the projects and their final products. Set up part of the rubric with minimum basic requirements, and let the students formulate, with your assistance, the other parts of the rubric. Review the completed rubric together and make certain that every student understands every part of the criteria that make up the rubric. All students should meet or exceed the criteria.
- Allow students to work individually, in pairs, or groups to do the projects.
- Provide students with opportunities to reflect on what they are doing. Encourage students to keep journals to record their experiences. This can help the teachers assess what students were thinking as they participated in lessons and worked on their projects. The journal should include the following information:

1. What did the student do?
 2. How did the student do it?
 3. What did the student learn?
- Allow the class to offer suggestions for improving the letter grades. The students will need to complete the project as homework.
 - Discuss what worked, what could be improved, and how it could be improved.
 - Ask students to discuss and then to write what they would do differently if they were to do this project again.

One way to organize a class project is described below:

- Before a topic or concept (big idea) will be studied (e.g., selected from California's content standards), ask students what they want to learn about this topic or concept.
 - Provide approximately two weeks as a preparation period. During this time students will learn the background for the topic or concept. Students should read books and articles, see videos, and check the internet. They might interview people in person or over the telephone.
 - Ask students whether they are interested in doing a project that ties into what they have been researching.
 - Brainstorm actual projects.
 - Evaluate these projects according to how feasible they are to implement.
 - Once students narrow the projects to one or two, decide unanimously which project to do.
 - Allow students to generate ideas on how to do the project.
 - Separate the project into tasks.
 - Encourage volunteers to select a task.
- Have students write a design plan to include the product (end result) and the process (how they will do it). Each student completes a design plan, even if working with partners or in groups.
 - Approve the design plan for each student or group of students.
 - Determine how much time should be provided to complete the project. (Try to keep the project time to approximately three weeks.)
 - Allow class time for students to work on their projects.
 - Design a related project that students can work on if they finish the original project early.
 - Have students turn in reports and be prepared to present their projects to the class.
 - Discuss what worked, what could be improved, and how it could be improved.
 - Ask students to discuss and then to write what they would do differently if they were to do this project again.

Note: K–3 projects may need to be more teacher directed.

Finally, make public what your students are doing. Have students make presentation panels with photographs and captions, tape conversations with students about their projects, and videotape students as they present their project reports. Display the presentation panels at school, during open house, and in various public places, such as the library or mall.

For more information on project-based learning, see the Web site for the Autodesk Foundation at www.autodesk.com/foundation. The Autodesk Foundation provides information for educators interested in project-based learning and also organizes a conference on the subject every spring.